Servicing Radio Receivers

ACE TRANSISTOR PORTABLE MODEL TR257

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HAVING now obtained a reasonable understanding of the A.F. application of transistors from last month's article on the Cossor Record Player, we extend the scope a little this month to embrace R.F. application in the consideration of a fully transistorised receiver.

The Ace transistor portable is designed for operation on the M.W. and L.W. bands over the range of 190 to 550 metres and 1,100 to 2,000 metres respectively on its inbuilt aerial. Provision is available for the connection of an external aerial and an external battery, the former greatly extending the range of pick-up and the latter resulting in economy of operation when the receiver is used indoors and the portable feature is not an essential consideration. The internal battery is a single lightweight, Ever Ready PP1, which gives about 150 hours of playing. The playing time is extended to about 800 hours by the use of an external Ever Ready PP8. The receiver can, if desired, be connected to a 6-volt car battery, or to a 12-volt car battery by way of an extra adaptor. For use in a car, the normal car aerial serves admirably to convey signals to the external aerial socket.

Known as the "Courier," the set is housed in a two-tone leathercloth case with plastic trim and handle. Even though of truly portable make-up, good reproduction is secured by way of a relatively large speaker, having dimensions 7in. × 4in., into which the output stage can feed a maximum of 0.25 watt.

The Circuit

Seven transistors and a germanium diode go to make up the circuit, full details of which are given on the next page. The first transistor, V1, is arranged as a self-oscillating additive mixer. Here the base of the stage is common to the input and output circuits from the point of view of the oscillator signal. The oscillator is a tuned-collector circuit, feedback taking place between the associated tuned circuit and the coil in the emitter circuit. Oscillator band-switching is achieved quite simply by changing over of the trimmers; on L.W. a 200 pF capacitor is connected in parallel with the L.W. trimmer.

The 470k resistor connecting the base to the negative side of the supply provides a starting current for the oscillator initially, but when oscillations commence a D.C. bias is developed across this resistor and associated 0.01 μF capacitor connected between the base and the ferrite aerial winding. This not only results in limiting and non-linearity which is the requirement of a mixer, but the self bias also acts as an automatic stabilising device for the stage. The stage, from the D.C. point of view, is arranged in the grounded-emitter mode by way of the emitter oscillator coupling coil and series-connected 3.3k resistor.

The appropriate windings on the ferrite aerial are selected by the wavechange switch sections, and the signal selected by the aerial section of the tuning gang is fed to the base of V1 through the 0.01 μF coupling capacitor. The non-linear operation of V1 results in the mixing of the oscillator and the incoming signals in the usual manner, and the 470 *kc/s I.F. signal* is developed across the first I.F. transformer (IFT 1), the primary being tapped to avoid damping by the collector circuit. V1 is of the Ediswan-Mazda range of junction transistors—Type XA102—being suitable as oscillator/mixer up to 2 Mc/s.

The I.F. Stage

The I.F. signal is amplified by two grounded-emitter stages, V2 and V3, using Ediswan-Mazda Type XA101 transistors. These are designed for use as I.F. amplifiers up to frequencies of 500 kc/s. Both I.F. transformers, IFT 2 and IFT 3, feature tapped primaries not only to resolve the matching problem, but also to facilitate the connection of neutralising circuits by way of the 5 pF capacitors wired between the tops of the primaries and the base circuits of V2 and V3. It must be remembered that the grounded-emitter mode is much after the style of a grounded cathode triode, and that to avoid the stage operating as a tuned-base tuned-collector oscillator (synonymous to a tuned-grid tuned-anode triode) some form of neutralising is called for.

The I.F. stages are stabilised with regard to their working points by resistive potential dividers in the base circuits in conjunction with

the resistors in the emitter circuits. The emitter resistors are decoupled at I.F. to prevent degeneration, while the base circuit of V2 is decoupled at A.F. so as to "hold-off" voltage fluctuations at A.F. due to the relatively heavy current variations in the push-pull output stage. Additional A.F. decoupling is given by the 100 μF capacitor and the 470-ohm resistor in the supply line directly after the output stage. R.F. and I.F. decoupling is secured by the 0.01 μF capacitor between chassis and the A.F.-decoupled supply line. It will be seen that this is effectively in parallel with the 100 μF capacitor.

The Detector and A.F. Amplifier

The type GD3 germanium detector, V4, is D.C. coupled to the base of the grounded-emitter A.F. amplifier stage, V5. The diode is connected to the base so that the rectified signal current is applied in the forward direction between the base-emitter junction. Under this condition, therefore, the bias applied to the base-emitter junction is dependent on the strength of the I.F. signal. So as to maintain this constant, which is essential to stabilise the working point of V5, and to endow the circuit with A.G.C., a D.C. connection is made from the emitter of V5 to the emitter of the first I.F. amplifier V2.

The operation is as follows: should the signal

circuit and the resistor in the emitter circuit.

The signal current in the collector circuit is abstracted by the driver transformer T1 and fed in push-pull mode to the bases of the grounded-emitter push-pull transistors V7 and V8. The collectors are wired across the primary of the centre-tapped output transformer and the loudspeaker is connected across the secondary winding. Negative feedback is applied over the driver and output stages from the secondary of the output transformer to the base of the driver valve through the 100-ohm resistor.

A test link is provided in the common collector circuit of the output transistors for the introduction of a current meter. The quiescent collector current is adjusted to put the output stages into class B mode by the 2k variable preset resistor in the base circuit.

The A.F. amplifier and driver transistors are by Ediswan-Mazda, Type XB102, while two Ediswan-Mazda XC101's, specially developed for class B operation, are adopted in the output stage.

Servicing Notes

In common with almost all transistorised portables, the Courier features a fully printed circuit. When replacing a component on such circuits it is usually advisable to cut the connecting wires of the faulty part so as to leave small lengths of

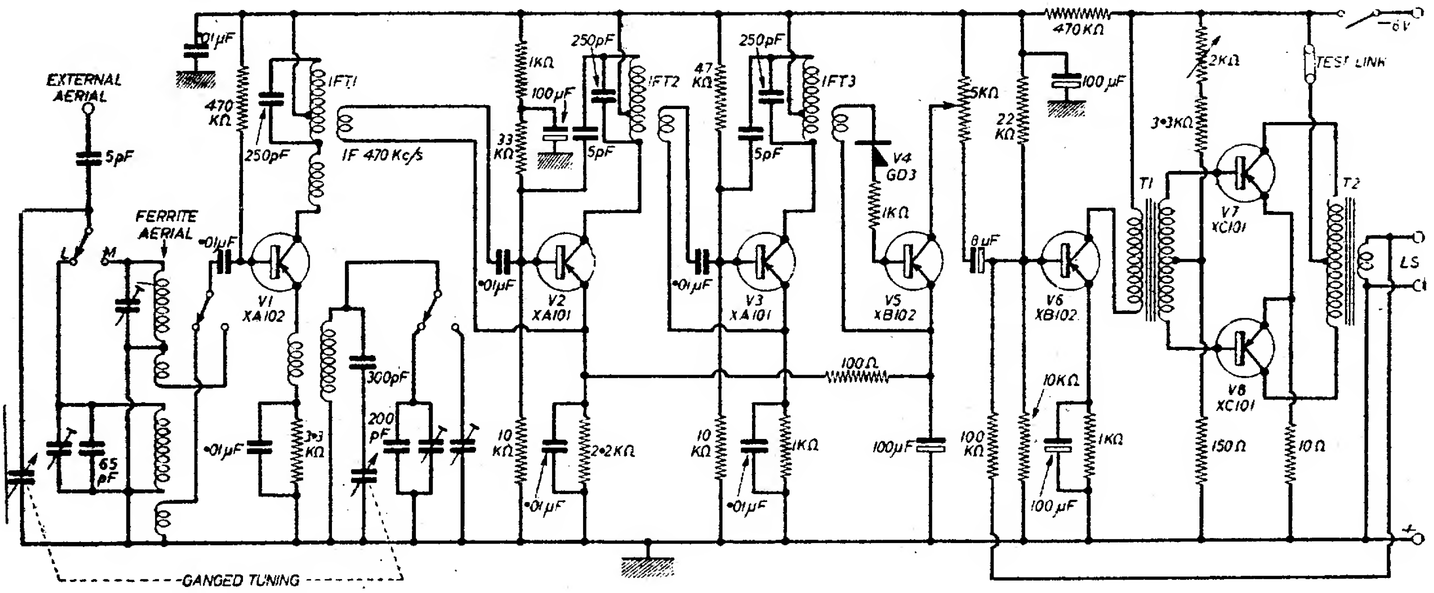

Fig. 1.—Circuit of the Ace transistor portable.

rise an increased current is caused to flow in V2 emitter resistor by way of the 100 ohm coupling resistor which biases V2 nearer cut-off and so reduces its amplification—rather like the more conventional valve A.G.C. system. Conversely, should the signal fall the amplification of the I.F. amplifier is increased. Thus, an A.G.C. compensating effect results, which is also valid to some degree in the stabilising for progressive reduction in battery voltage.

The Driver and Output Stages

The signal current in the collector circuit of V5 is capacitively coupled (note the large value capacitor used) to the base of the grounded-emitter driver stage V6. This stage is stabilised by the resistive potential-divider in the base

the original wires protruding through the panel for ease of connection of the replacement part. A miniature soldering iron of some 25 watts is recommended so as to avoid damaging the adjacent components, printed wiring and panel. A large iron invariably results in a blob of solder shorting adjacent wires or connecting tags, and prolonged heat in an endeavour to remove the short usually ends up in a burnt panel. If a solder short of this kind occurs, it can be cleared with little difficulty by means of a small stiff brush when the solder is in a molten state—a salvaged tooth-brush serves admirably. Before the actual soldered connection of replacement parts, the heat application can be considerably reduced by first tinning the wires protruding from

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the panel and the component connecting wires themselves. Small hooks can be formed on the wire ends so as to hold the components in position during the soldering process. A quick touch with a hot iron is all that is then necessary to obtain a good electrical connection.

After a printed circuit has several times been removed from a cabinet it often happens that a fracture occurs on one of the printed wires. This may well be revealed by the receiver cutting on or off as the printed panel is subjected to stress. Sometimes it is difficult to locate the position of the fracture by visual means, but finger pressure applied in turn to various sections of the panel soon brings the trouble to light. The connection is best repaired by soldering a small piece of 5-amp fuse wire across the fracture; a blob of solder serves the same purpose, of course, but has been found to be less reliable. It should be noted that a coating of varnish is invariably given to printed circuit, and this must be carefully removed from a faulty section before a good soldered joint can be made.

Generally speaking, transistor receivers are reasonably reliable, possibly more so than valve circuits in which considerably higher voltages and currents are present. When a fault occurs, however, consideration is immediately given to the condition of the transistors themselves. They are not easily tested in-situ, as are their valve counterparts. With the small voltages and currents present in the circuits, the limits given in design and the possible partly exhausted condition of the battery, meter readings made while the set is switched on, possibly with a meter of slight inaccuracy, may do more to bewilder the operator than assist him.

Apart from complete breakdown, it is best to remove suspect transistors from the circuit, or transistors from a suspect stage, and check the associated resistors and capacitors individually. Later, substitution tests may be performed, particularly of electrolytic capacitors, if found necessary. With the condition of the associated parts checked, the transistor should next be checked, preferably by substitution. If this is not possible, however, it can be wired into a test network with a milliammeter in the collector-base circuit in series with a 4.5-volt battery, with battery negative to collector (most important). With zero emitter current, the collector current in a junction transistor should be in the region of 20 microamps, or possibly less. This should rise to a milliamp or so by applying about 1 mA to the emitter-base circuit from a 1.5-volt battery by way of a 1.2k resistor. If this does not happen, bearing in mind that the emitter-base junction has to be biased in the forward direction (i.e., battery postive to emitter), the transistor is faulty.

When replacing or removing transistors heat from the soldering iron should be by-passed by gripping the connecting wires, between the transistor and iron, with a *cool* pair of long-nosed pliers. Failure to observe this simple rule is liable to ruin a good transistor, all of which are very heat sensitive.